ASHRAEJune2010Rpt

JUNE 2010 ESTIMATES

OF

BRIGGS ET AL. BUILDING CODE SPATIAL DISTRIBUTION

by

Charles H. Whitlock, William S. Chandler, James M. Hoell, David J. Westberg,

Taiping Zhang

Science Systems and Applications, Inc., Hampton VA 23666-5845

and

Paul W. Stackhouse, Jr.

Mail Stop 420, NASA Langley Research Center, Hampton, VA 23681-2199

A Briefing Report for the ASHRAE Technical committee 4.2 on Climatic Information

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Albuquerque, NM

June 2010

INTRODUCTION

A NASA study entitled "***High Spatial Resolution Global Climate Data in Support Of The Buildings and Renewable Energy Industries"*** was selected for funding by NASA through a peer reviewed proposal that uses an advanced reanalysis data set known as **MERRA** (Modern Era Retrospective-analysis for Research and Applications). Partners for the proposal are NASA's Langley Research Center (Dr. Paul Stackhouse and Dr. Charles Whitlock) and Goddard Space Flight Center (Dr. Michael Bosilovich) with contributions from Department of Energy (Dr. Drury Crawley). A long-term objective of this work is to define and map the Briggs et al. buildings climate zones over the globe in rural areas using satellite-based reanalysis methods. It is recognized that the present version of MERRA is most applicable to rural regions. Advanced versions may include additional physics to allow more accurate analysis of cities in the future.

It must be noted that this work is intended to assist a number of both national and international organizations. NASA generally recommends that quality ground-site-measured data be used whenever possible. If that is not available; satellite-based radiation, reanalysis, or modeling data may be useful for preliminary design purposes. A number of users have found the satellite and reanalysis data of value. See http://eosweb.larc.nasa.gov/cgi-bin/sse/sse.cgi?+ss11#s11.

Initial study results were reported to ASHRAE TC 4.2 at their January 2010 meeting. A copy of the January report is provided in the APPENDIX which follows the text section of this report. The purpose of this report is to describe progress as of mid-June 2010.

PROGRESS AS OF JUNE 2010

Analyses over the past 6 months has centered on the northwestern part of the United States because it is a complicated coastal, mountain and plains region. Figure 1 below shows the Briggs, et al. ASHRAE climate zone map for this region. In general, boundaries between the various climate zones are located along county borders to aid enforcement of building codes.

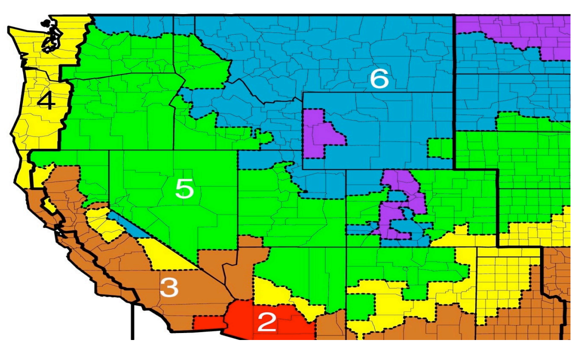

Fig 1: ASHRAE climate zone map produced in 2004 from Briggs, et al.

Previous NASA attempts to globally map Briggs et al. climate zones used GEOS-4 1x1 degree latitude/longitude reanalysis data (Fig 2 below) have not been accurate. MERRA 2/3 x 1/2 degree results are more detailed as shown in Fig. 3.

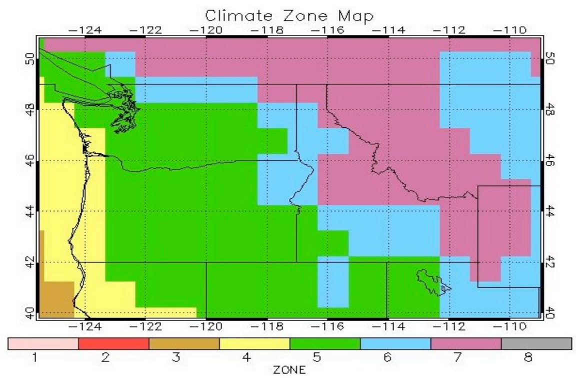

Fig. 2: Basic GEOS-4 1 x 1 deg map of the Northwest United States using Briggs et al. climate zone definitions without NCDC/USGS topography-based lapse-rate adjustments.

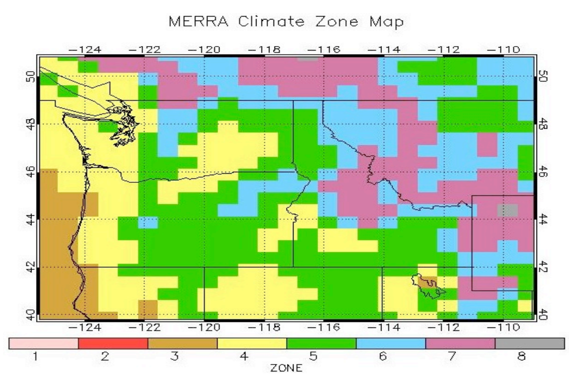

Fig. 3: Basic MERRA 2/3 x 1/2 deg latitude/longitude Briggs, et al. climate map of the Northwest United States without NCDC/USGS topography-based lapse-rate adjustments.

Application of NCDC/USGS 10-minute latitude/longitude topography lapse-rate adjustments produce dramatic changes on both GEOS-4 and MERRA climate-zone maps (Figs 4 and 5).

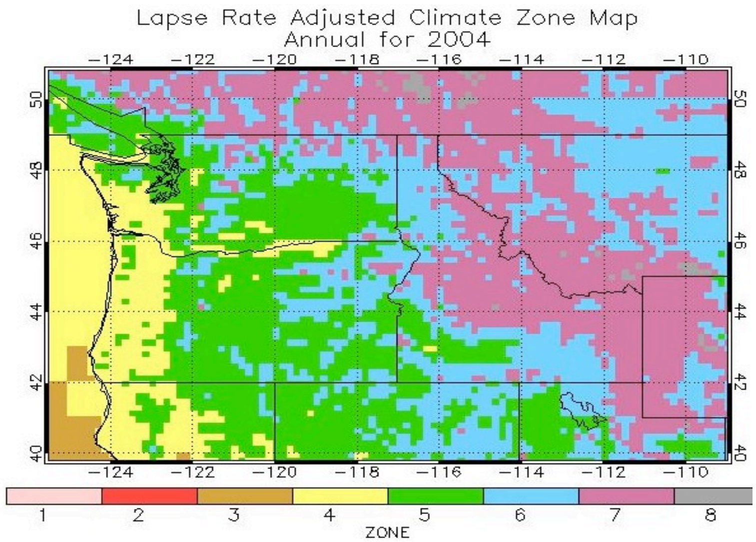

Fig. 4: Basic GEOS-4 1 x 1 deg Briggs et al. climate map of the Northwest United States with NCDC/USGS 10-minute latitude/longitude topography lapse-rate adjustments.

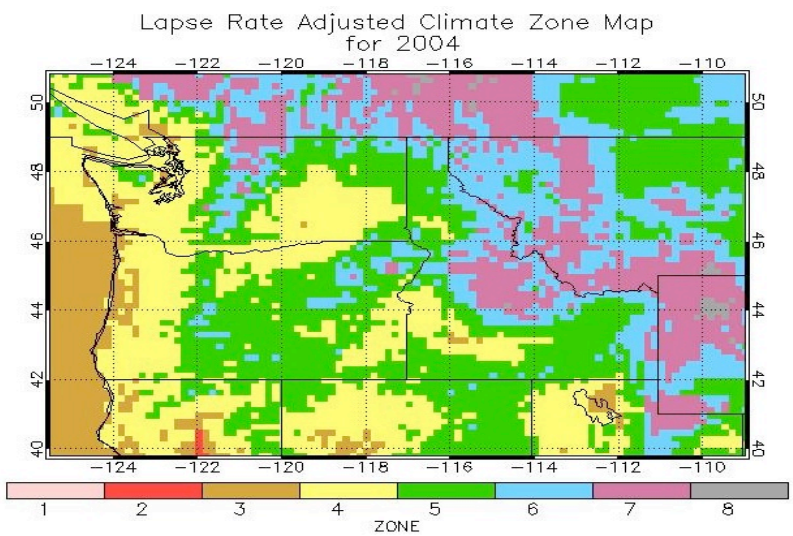

Fig. 5: Basic MERRA 2/3 x 1/2 deg Briggs et al. climate map of the Northwest United States with NCDC/USGS 10-minute latitude/longitude topography lapse-rate adjustments.

Lapse-rate adjusted MERRA values are more detailed and show variation in climate zones along the coast caused by coastal plains and coastal mountains. It should be noted that Fig. 5 land climate zone variation along the Washington and Oregon coasts are in reasonable agreement with topography maps of that region in the 18th EDITION of the Rand McNally GOOD'S

WORLD ATLAS. Temperature boundaries between warmer and cooler ocean currents may also be more accurate with the MERRA 2/3 x 1/2 deg data even though topography-based lapse-rate adjustments are not applied to water bodies.

OTHER MERRA BUILDINGS-RELATED PARAMETERS

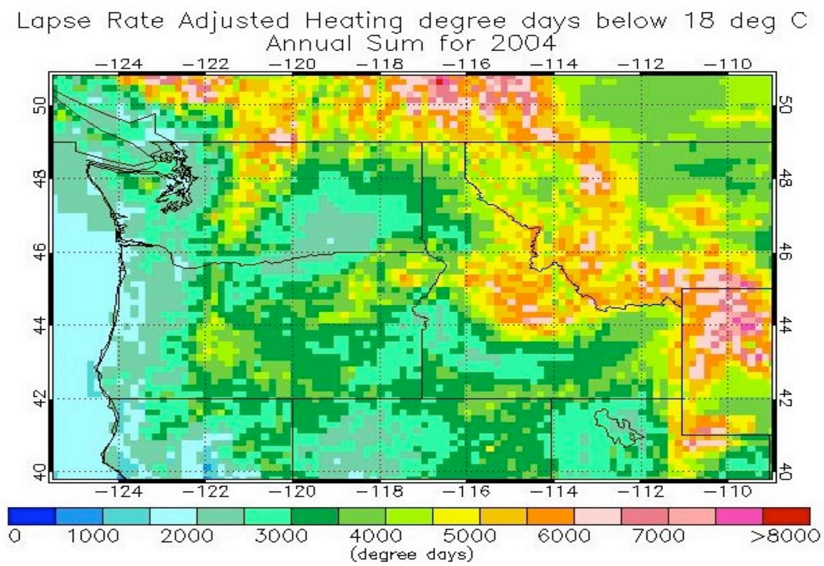

Fig 6: 10 x 10 minute from MERRA 2/3 x 1/2.

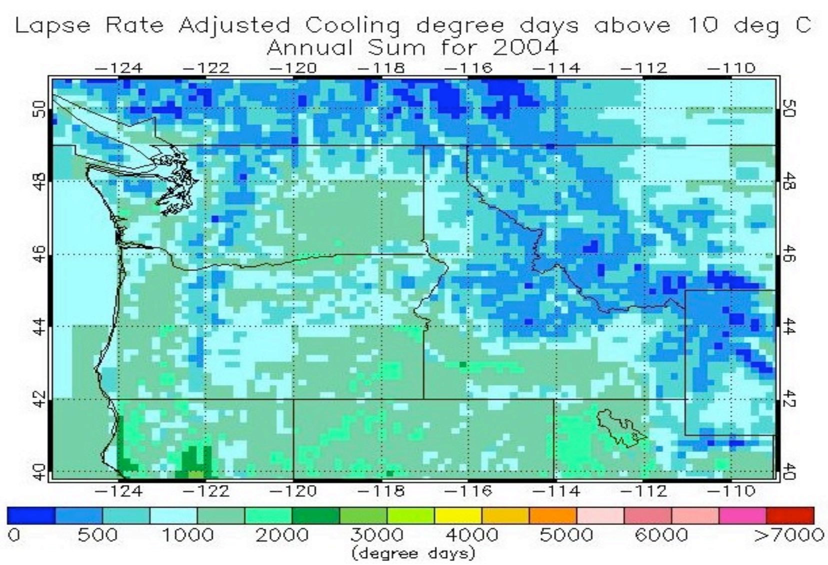

Fig 7: 10 x 10 min from MERRA.

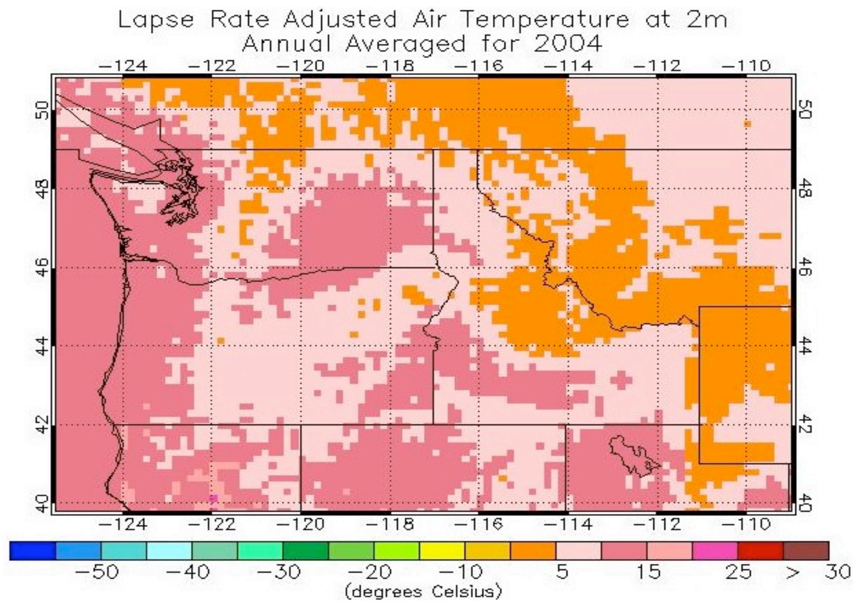

Fig 8: 10 x 10 minute from MERRA 2/3 x 1/2.

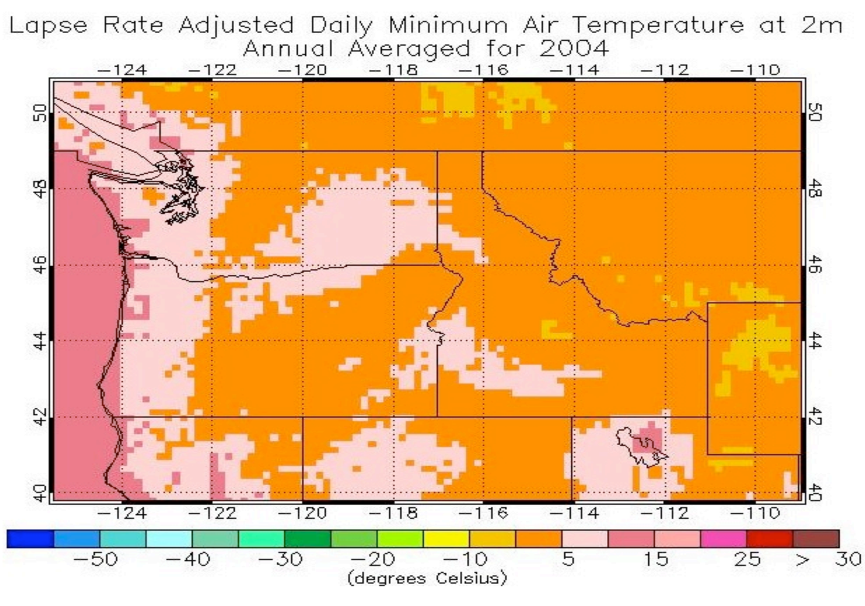

Fig 9: 10 x 10 minute from MERRA 2/3 x 1/2

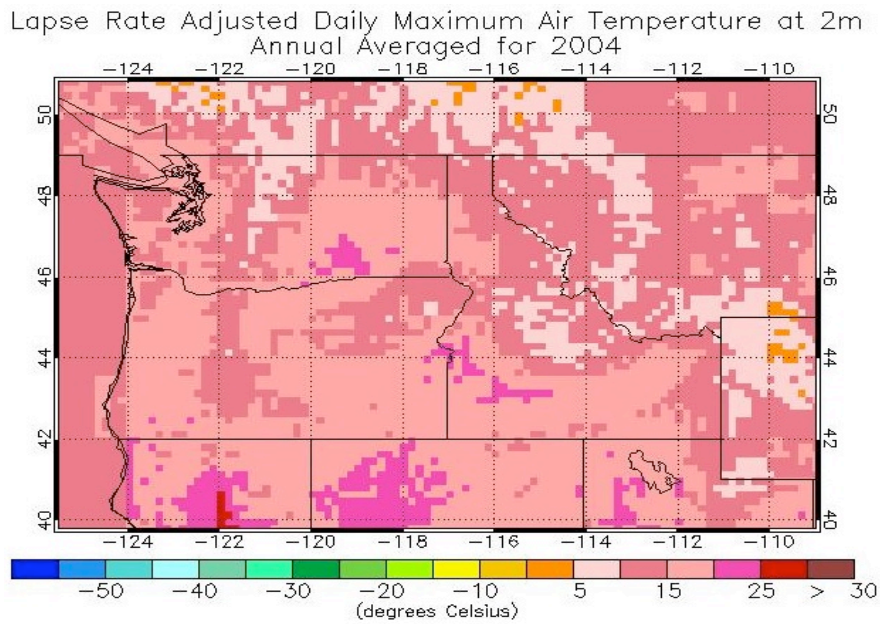

Fig 10: 10 x 10 minute from MERRA 2/3 x 1/2.

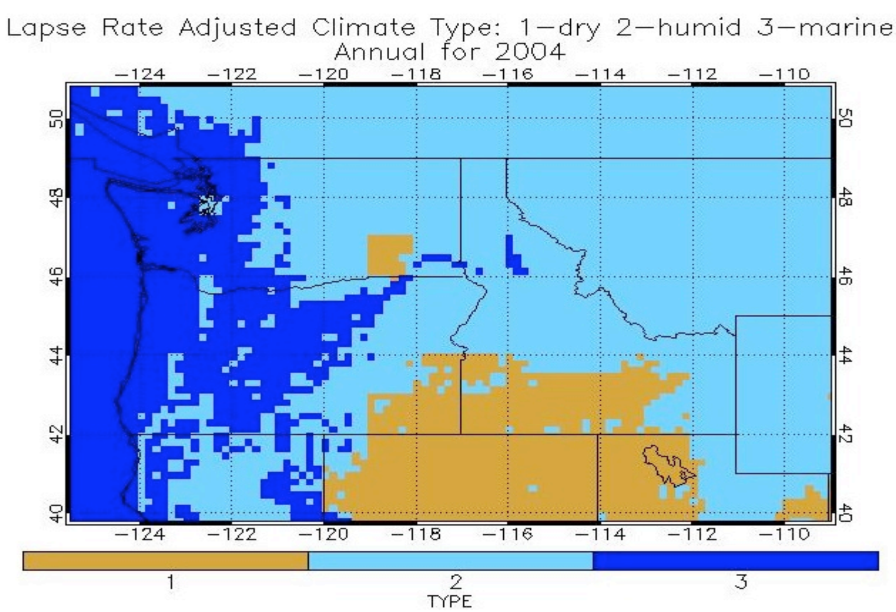

Fig 11: 10 x 10 minute from MERRA 2/3 x 1/2

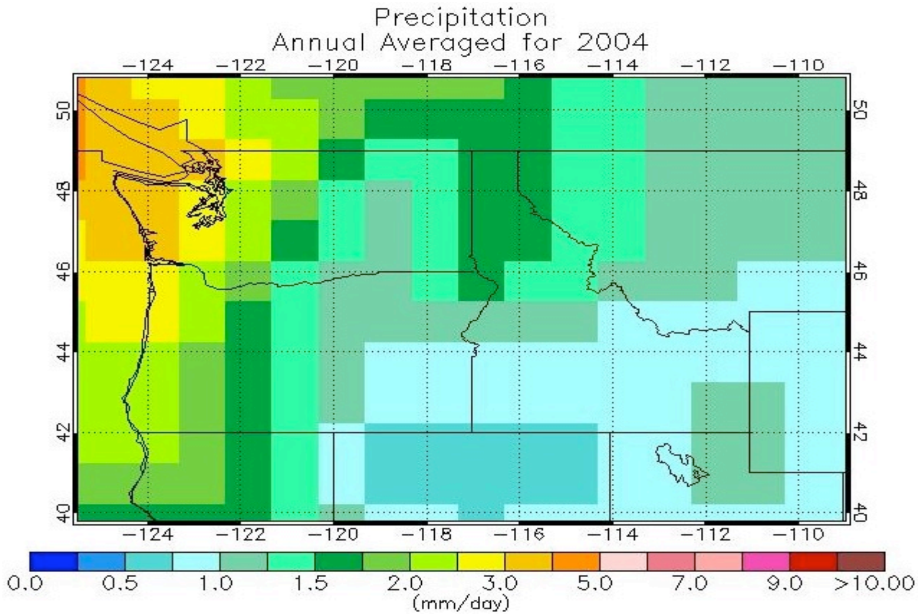

Fig 12: 1 x 1 degree precipitation calculated by bilinear interpolation of 2.5 x 2.5 GPCP monthly averaged data.

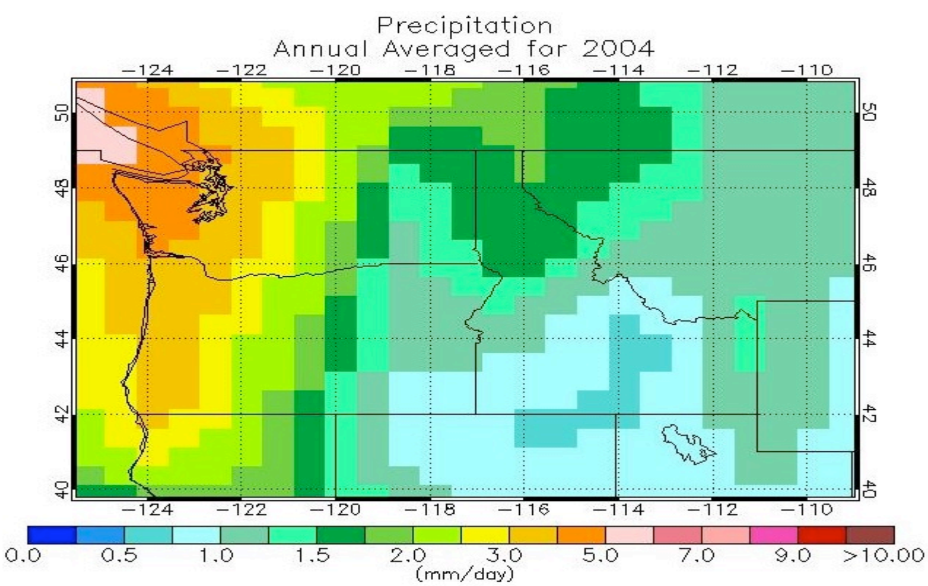

Fig 13: 2/3 x 1/2 precipitation calculated by bilinear interpolation of 2.5 x 2.5 GPCP monthly averaged data.

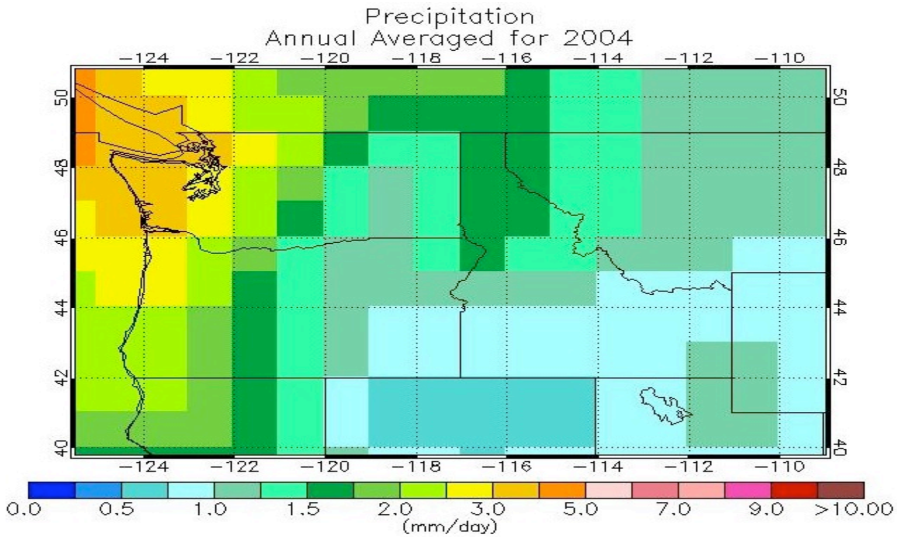

Fig 14: 10 x 10 minute precipitation calculated by duplicating the 1 x 1 degree precipitation calculated by bilinear interpolation of 2.5 x 2.5 GPCP monthly averaged data

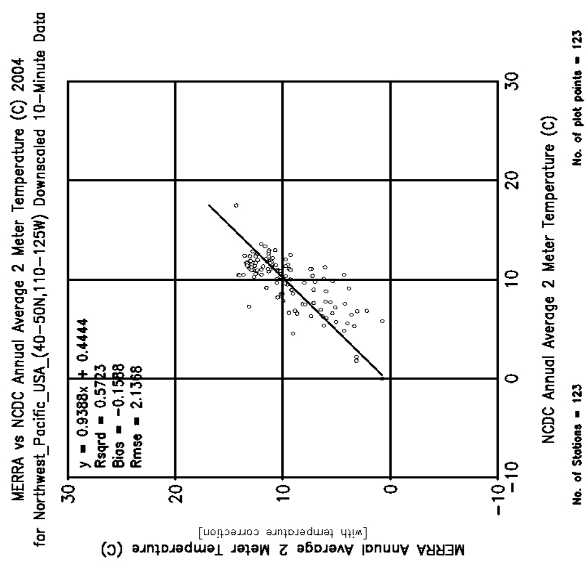

Fig 15: Comparison of MERRA and NCDC annual average temperatures over the northwest Pacific region of the U.S.

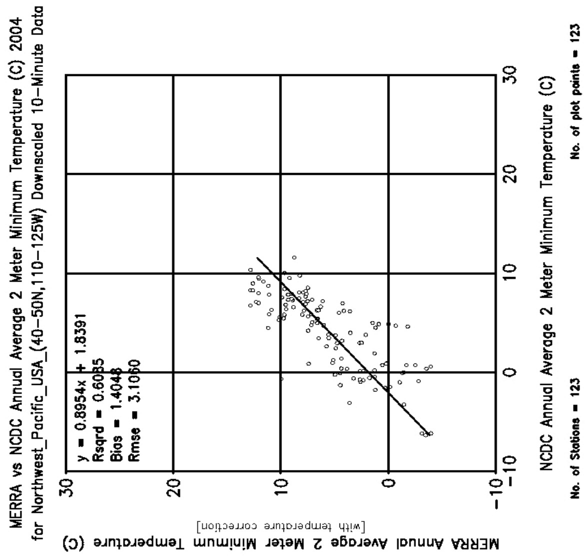

Fig 16: Comparison of MERRA and NCDC annual minimum temperatures over the northwest Pacific region of the U.S.

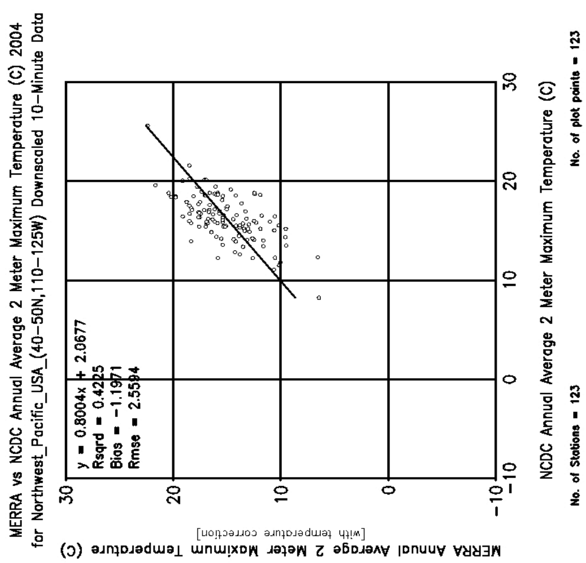

Fig 17: Comparison of MERRA and NCDC annual maximum temperatures over the northwest Pacific region of the U.S.

Charts 17, 18, and 19 should be considered preliminary. It was noted earlier that MERRA is believed to be most applicable to rural areas because of the physics that are contained in the present version used in this study. The NASA team has not had an opportunity to sort through the various ground site locations in Figs 15, 16, and 17 to categorize which are rural and which are urban. It should also be noted that NCDC considers their ground site temperature measurements to have average bias uncertainties of -0.65 deg C and RMS uncertainties of 3.076 deg C (National Weather Service Instruction 10-1302, page A-5). Our NASA team plans to study these issues in the near future.

APPENDIX

PRELIMINARY COMPARISON

OF

BUILDINGS CLIMATE-ZONE MAPS

FOR THE

UNITED STATES

by

Charles H. Whitlock, William S. Chandler, David J. Westberg, James M. Hoell

and Taiping Zhang

Science Systems and Applications, Inc., Hampton, VA, 23666-5845

Paul W. Stackhouse Jr.

Mail Stop 420, NASA Langley Research Center, Hampton, VA 23681-2199

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ASHRAE Technical Committee 4.2 on Climatic Information

2010 ASHRAE Winter Meeting

Orlando, FL

January 23-27, 2010

Sponsored

by the

NASA Applied Sciences Program

Earth Science Mission Directorate

SUMMARY

A NASA study entitled "***High Spatial Resolution Global Climate Data in Support Of The Buildings and Renewable Energy Industries"*** was selected for funding by NASA through a peer reviewed proposal that uses an advanced reanalysis data set known as **MERRA** (Modern Era Retrospective-analysis for Research and Applications). Partners for the proposal are NASA's Langley Research Center (Dr. Paul Stackhouse and Dr. Charles Whitlock) and Goddard Space Flight Center (Dr. Michael Bosilovich) with contributions from Department of Energy (Drury Crawley). The results available as of January 15, 2010 are shown in following charts and tables as described.

Charts 1 and 2 compare the original Briggs, et al. buildings climate zone map with a USGS elevation map. It must be emphasized that Briggs, et al. acknowledge in their web site report that there may be a problem with the assumption of a constant altitude within counties. The assumption had to be made because building codes are fixed on a county-wide basis over most of the United States. That is **not** the situation over the whole globe.

NASA has developed a correction procedure that can be used to spatially 'downscale' temperature fields from NASA's reanalysis models such as MERRA which provides estimates of the average temperatures over the model grid element to a local ground site. For the MERRA model the grid element is 2/3 x 1/2 degree. Chart 3 illustrates how terrain height may change over the model grid area, and illustrates the need to take into account the complexity of the terrain when using the modeled temperature fields, as well as extrapolating ground site observations to non-observational sites as was done in construction the climate zone map shown in Chart 1. We note that our original proof-of-concept analysis used the NASA reanalysis model designated as GEOS-4 which had a 1-degree grid cell. Our downscaling scaling approach is based upon the use of lapse rates derived through "calibration" of the NASA model values to observations from a local to regional ground network. These lapse rates along with model bias are used to adjust the model temperatures to local ground site values. This initial work has been presented at a previous meeting of Technical Committee 4.2.

Chart 4 shows an estimate of the Briggs, et al. climate zones over the United States after corrections were applied to the 1 x 1 degree latitude/longitude reanalysis model temperatures. Chart 4 is an estimate of climate zone distribution on a 10-minute latitude/longitude scale. Height adjustments were based on the difference in height between that of the 1-degree reanalysis model cell and that of the actual USGS 10-minute topography value in Chart 2. The Chart 4 title notes that the Briggs, et al. climate zone distributions are similar to a map of Natural Vegetation in GOODE'S World Atlas.

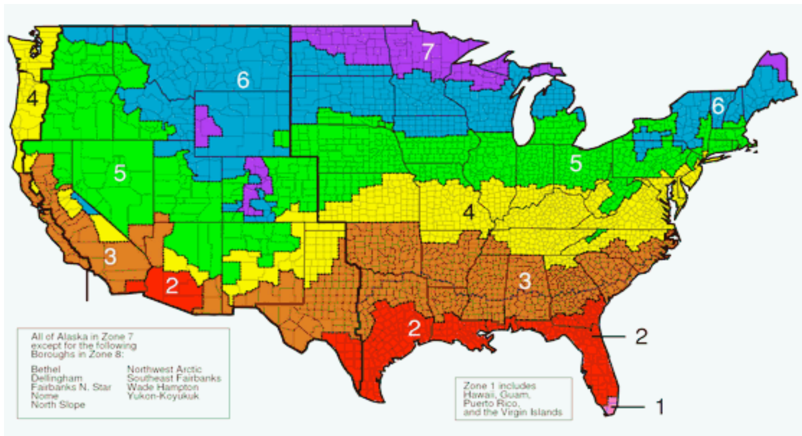

Chart 1. Original buildings climate zone map based on cluster analysis for counties using 1961 - 1990 NCDC SAMPSON ground-site data from 230 sites. ASSUMES CONSTANT-HEIGHT TOPOGRAPHY WITHIN EACH COUNTY according to Briggs, Lucas, and Taylor, www.energy codes, 2000.

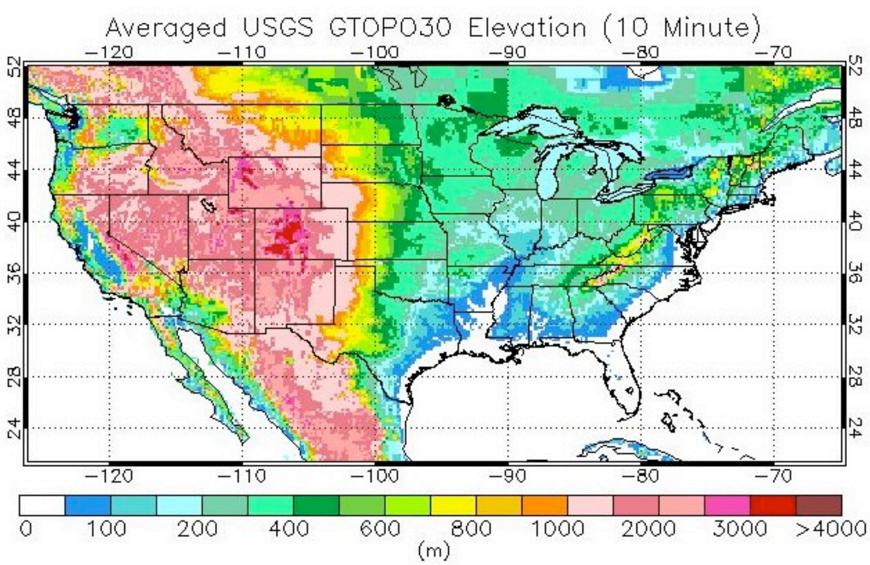

Chart 2. Earth-surface elevation above mean sea level at 10-minute latitude/longitude spatial resolution.

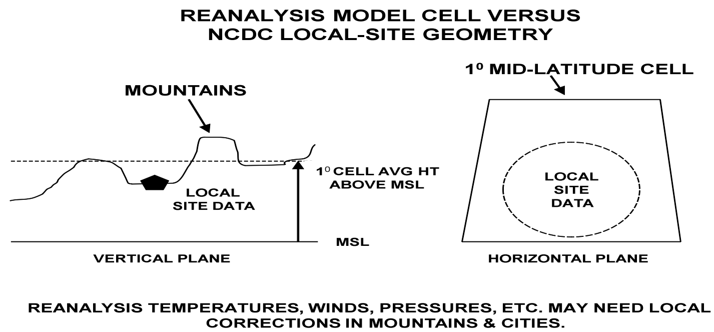

Chart 3. Height and horizontal influence of a local meteorological site in a valley within a 1-degree GEOS-4 cell in the mountains.

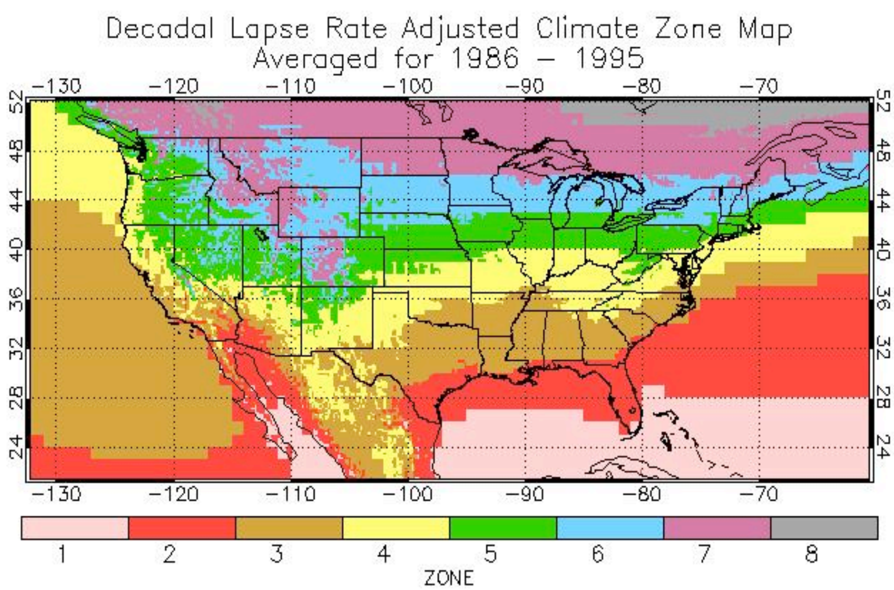

Chart 4. NASA buildings climate zone map using Briggs et al. climate zone definitions with satellite and radiosonde reanalysis one-degree data in combination with lapse-rate corrections based on 10-minute spatial resolution USGS topography values (Chart 2). (Note: For interior regions, this map has similar patterns to the NATURAL VEGETATION map in Rand McNally GOODE'S WORLD ATLAS, 18th edition, 1990, pp. 66.)

The discussion above leads to the following schedule for this NASA effort.

1. Analyze MERRA lapse rate and offset corrections using native grid. Compare to surface measurements and to results using GEOS-4. (note: collaborate with NASA GSFC for data products, analysis) --- December 2009

2. Interim report to ASHRAE Climate Committee---------------------------- January 2010

3. Complete analysis of regional and seasonal lapse rate and offset corrections in collaboration with GSFC -- February 2010

4. Analyze annual precipitation fields from GPCP, TRMM, and MERRA in collaboration with GSFC --- May 2010

5. Complete draft of 10 minute climate zone map of Western US/US Plains regions -- June 2010

6. Presentation of Draft Final report to ASHRAE Climate Committee ---------- June 2010

7. Complete assessment of draft map in terms of impact to current zones; potential global land processing based upon assessment -- August 2010

8. Completion of final feasibility report to NASA --------------------- September 30, 2010

9. Completion of Task Final Report/Submission to ASHRAE Climate Committee (next meeting January 2011) --- September 30, 2010